Multi-scale impact assessments can help detect impact, infer its mechanism and consequences and provide tools for management

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Abstract

Boat traffic, and particularly the traffic associated with the tourism industry, generates a significant proportion of the noise to which cetaceans are exposed because of the overlap between coastal cetacean habitat and this activity. Interactions with vessels are chronic intermittent stressors for cetaceans, but the long-term consequences of these impacts are often difficult to detect due to methodological issues. We report on the framework of a study conducted in Doubtful Sound, New Zealand which assessed the effects of boat interactions on bottlenose dolphins (*Tursiops* spp.). We tested whether the presence of boats, their type, and their behaviour, affected the diving pattern of individuals, the behavioural events observed in groups of dolphins as well as the behavioural state of these groups. We therefore looked for various short-term reactions at the individual and group levels. Combining the effects observed at these two ecological levels allowed us to infer both the mechanisms by which vessel interactions were impacting the dolphins and the long-term biological cost of these interactions for individuals and the population. We found that dolphins were more sensitive to boat presence when they were resting or socialising. We also showed that boats misbehaving increased the effect size of the impact, especially for females. We proposed a multi-level reserve to mitigate these effects based on the dolphins' spatial behavioural ecology. Adapting the management of boat interactions to reduce exposure, either spatially or temporally, during sensitive behavioural states is likely to be an efficient mitigation tool. We think that this framework could be readily applied to other situations where the detection and mitigation of anthropogenic impacts on animals is required.